

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>A61K 38/28</b>		A1	(11) International Publication Number: <b>WO 96/36352</b> (43) International Publication Date: 21 November 1996 (21.11.96)		
(21) International Application Number: PCT/CA96/00305		(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).			
(22) International Filing Date: 16 May 1996 (16.05.96)					
(30) Priority Data: 08/442,358 16 May 1995 (16.05.95) US					
(71)(72) Applicants and Inventors: MODI, Pankaj [CA/CA]; Apartment 608, 1928 Main Street West, Hamilton, Ontario L8S 1J4 (CA). CHANDARANA, Subash [CA/CA]; 2259 Kirkburn Drive, Burlington, Ontario L7P 4E8 (CA).		Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>			
(74) Agent: GUARDIAN INTELLECTUAL PROPERTY SERVICES; 2103 Constance Drive, Oakville, Ontario L6J 5V1 (CA).					
(54) Title: LIQUID FORMULATIONS FOR PROTEINIC PHARMACEUTICALS COMPRISING AT LEAST 2 ABSORPTION ENHANCERS					
(57) Abstract					
A liquid pharmaceutical agent formulation suitable for oral or nasal delivery comprises a proteinic pharmaceutical agent, water and at least two absorption enhancing compounds. The adsorption enhancing compounds are selected from sodium salicylate, sodium lauryl sulphate, disodium ethylenediaminetetraacetic acid (disodium EDTA), oleic acid, linoleic acid, monoolein, lecithin, lysolecithin, deoxycholate, sodium deoxycholate, chenodeoxycholate, taurodeoxycholate, glycochenodeoxycholate, polyoxyethylene X-lauryl ether wherein X is from 9 to 20, sodium tauro-24, 25-dihydrofusidate, polyoxyethylene ether, polyoxyethylene sorbitan esters, p-t-octylphenoxy polyoxyethylene, N-lauryl- $\beta$ -D-maltopyranoside, 1-dodecylazacycloheptane-2-azone and phospholipids, wherein the amount of each of the absorption enhancing compounds is present in a concentration of from 1 to 10 wt./wt.% of the total formulation. Preferably each of the absorption enhancing compounds is present in a concentration of from 1.5 to 3.5 wt./wt.%. The formulation is particularly adapted to oral delivery of insulin. A preferred insulin formulation contains about 2 wt.% each of chenodeoxycholate, deoxycholate and polyoxyethylene 9-lauryl ether absorption enhancers, an inorganic salt, e.g. sodium chloride, a protective polymer, e.g. gelatin, a protease inhibitor, e.g. bacitracin, and optionally an antioxidant, e.g. tocopherol.					

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

**LIQUID FORMULATIONS FOR PROTEINIC PHARMACEUTICALS COMPRISING AT LEAST 2 ABSORPTION ENHANCERS**

Technical Field

5       The present invention relates to an improved delivery system for the administration of pharmaceuticals, e.g. peptidic drugs, vaccines and hormones. In particular it relates to insulin, vaccines and hormones which may be orally administered.

Background

10      In the treatment of diabetes, current subcutaneous insulin therapy is limited by the delayed time of onset and time of peak action for the insulin, inability to accommodate changing insulin requirements, e.g. during exercise or meals, and by the large inter- and intra-  
15      subject coefficient of variation of absorption and insulin action. Oral delivery of insulin would overcome many of the disadvantages of the subcutaneous delivery system.

20      The inability of subcutaneous insulin delivery to effectively and safely control glucose levels has encouraged exploration of alternate, less painful methods of delivery that might provide a faster rate of insulin absorption and a relatively short half life.  
Oral administration of insulin to treat diabetes is  
25      likely to be attractive because of its virtual lack of toxicity and its inherent clinical applicability in the reduction in severity of lymphocytic infiltration of pancreatic islets. Furthermore, it has been shown that splenic T-cells from animals orally treated with insulin  
30      adoptively transfer protection against diabetes, which indicates that oral insulin generates active cellular mechanisms that suppress disease. Such results suggest that oral insulin affects diabetes and the pancreatic cellular inflammatory process and raises the possibility  
35      that oral administration of insulin may provide a new approach for the treatment of autoimmune diabetes.

As indicated, oral delivery of insulin would have many benefits. Oral delivery is also a preferred method

- 2 -

of delivering many other therapeutic or pharmaceutical agents. In some instance, even nasal delivery is preferred from a patient point of view because it is not painful like subcutaneous administration and it may be easily self-administered. Nasal delivery of therapeutic agents has the disadvantage that the amount of agent (dose) delivered varies from one dose to another, for a variety of reasons. For example, the lining of the nose is sensitive and sneezing or dripping as a result of irritation of the lining causes loss of usable therapeutic agent. Oral delivery of therapeutic or pharmaceutical agents overcome these difficulties. Even so, if a nasal delivery method is desired, an improved formulation would be helpful.

Effective oral delivery of a pharmaceutical agent requires that the agent has sufficient solubility in the stomach and intestinal lumen and the ability to pass through the intestinal wall. Many peptidic drugs have extremely poor absorption in the gastrointestinal tract and tend to degrade quickly. For example insulin, when introduced orally, has extremely poor absorption in the gastrointestinal tract, tends to degrade quickly, and thus has no metabolic effect on blood glucose levels.

M. Kidron, H. Bar-on, E.M. Berry and E. Ziv in Life Sciences, vol 29, pp 803-9 (1981) and vol 31, pp 2837-41 (1982) have experimented in small animals, with surgical delivery of insulin to the small intestine of a composition of 5 wt.% of an absorption enhancer, e.g. sodium cholate, 2 wt% soyabean trypsin inhibitor and 15 IU of insulin. Such a composition had a metabolic effect on blood sugar level, i.e reduced the blood sugar level by about 30%. However a large amount of insulin was required to produce this effect. The method is obviously not practical in humans and the amount of insulin required would be prohibitively expensive.

A composition which provides effective and practical oral or for some compositions, nasal delivery

- 3 -

of pharmaceutical agents has been found.

Disclosure of Invention

Accordingly the present invention provides a liquid pharmaceutical agent formulation suitable for oral or nasal delivery comprising a proteinic pharmaceutical agent, water and at least two absorption enhancing compounds selected from the group consisting of sodium salicylate, sodium lauryl sulphate, disodium ethylenediaminetetraacetic acid (disodium EDTA), oleic acid, linoleic acid, monoolein, lecithin, lysolecithin, deoxycholate, sodium deoxycholate, chenodeoxycholate, taurodeoxycholate, glycochenodeoxycholate, polyoxyethylene X-lauryl ether wherein X is from 9 to 20, sodium tauro-24, 25-dihydrofusidate, polyoxyethylene ether, polyoxyethylene sorbitan esters, p-t-octylphenoxy polyoxyethylene, N-lauryl- $\beta$ -D-maltopyranoside, 1-dodecylazacycloheptane-2-azone and phospholipids, wherein the amount of each of the absorption enhancing compounds is present in a concentration of from 1 to 10 wt./wt.% of the total formulation.

Sodium lauryl sulphate is sometimes referred to as sodium dodecylsulphate.

In a preferred embodiment the concentration of each of the absorption enhancing compounds is from 1 to 5 wt./wt.% and especially from 1.5 wt./wt.% to 3.5 wt./wt.%

In a preferred embodiment the absorption enhancing compounds are selected from a combination of deoxycholate, chenodeoxycholate, and polyoxyethylene 9-lauryl ether, a combination of sodium salicylate, deoxycholate, chenodeoxycholate, and polyoxyethylene 9-lauryl ether, a combination of sodium deoxycholate, chenodeoxycholate, polyoxyethylene 9-lauryl ether and monoolein, a combination of deoxycholate, chenodeoxycholate and sodium salicylate, a combination of deoxycholate, sodium salicylate and sodium lauryl

- 4 -

sulphate, a combination of deoxycholate,  
chenodeoxycholate, polyoxyethylene 9-lauryl ether and  
sodium tauro-24, 25-dihydrofusidate, a combination of  
sodium deoxycholate, chenodeoxycholate, polyoxyethylene  
5 9-lauryl ether and sodium tauro-24, 25-dihydrofusidate,  
a combination of deoxycholate, chenodeoxycholate,  
taurodeoxycholate, polyoxyethylene 9-lauryl ether and  
monoolein, a combination of chenodeoxycholate,  
glycochenodeoxycholate, polyoxyethylene 9-lauryl ether  
10 and sodium tauro-24, 25-dihydrofusidate, a combination  
of chenodeoxycholate, sodium lauryl sulphate and  
disodium EDTA, a combination of deoxycholate,  
chenodeoxycholate, polyoxyethylene 9-lauryl ether and  
disodium EDTA, a combination of sodium salicylate,  
15 disodium EDTA and polyoxyethylene 9-lauryl ether, a  
combination of monoolein, oleic acid and polyoxyethylene  
sorbitan ester, a combination of monoolein, oleic acid,  
polyoxyethylene sorbitan ester and sodium lauryl  
sulphate, and a combination of linoleic acid, monoolein  
20 and sodium salicylate.

A preferred polyoxyethylene sorbitan ester is  
available under the trade mark Tween 80.

In one embodiment one of the enhancing compounds is  
polyoxyethylene X-lauryl ether, wherein X is 9 or 10.

25 In another embodiment the phospholipid is selected  
from the group consisting of lecithin, lysolecithin,  
sphingomyelin, phosphatidylcholine, cephalin and  
phosphatidylethanolamine.

The most preferred absorption enhancing compounds  
30 are deoxycholate, chenodeoxycholate, polyoxyethylene 9-  
lauryl ether, sodium salicylate, monoolein and sodium  
tauro-24, 25-dihydrofusidate. These in particular, when  
combined with each other, or with others of the named  
absorption enhancing compounds, are the most effective.

35 Preferred combinations are i) deoxycholate,  
chenodeoxycholate and sodium salicylate, ii) sodium  
salicylate, deoxycholate and sodium lauryl sulphate,

- 5 -

iii) chenodeoxycholate, sodium lauryl sulphate and disodium EDTA and iv) monoolein, oleic acid and polyoxyethylene sorbitan ester, v) deoxycholate, chenodeoxycholate and polyoxyethylene 9-lauryl ether.

5 The most preferred combination is deoxycholate, chenodeoxycholate and polyoxyethylene 9-lauryl ether.

For insulin-containing compositions, it is preferred that the composition also contains at least one inorganic salt which opens channels in the 10 gastrointestinal tract and may provide additional stimulation to release insulin. Non-limiting examples of inorganic salts are sodium, potassium, calcium and zinc salts, especially sodium chloride, potassium chloride, calcium chloride, zinc chloride and sodium bicarbonate.

15 It is also preferred that the composition contain at least one protective polymer for slow release of the pharmaceutical agent. Preferred protective polymers are polyvinyl alcohol, polyethylene glycol, and gelatin.

20 It will be recognized by those skilled in the art that for many pharmaceutical compositions it is usual to add at least one antioxidant to prevent degradation and oxidation of the pharmaceutically active ingredients. It will also be understood by those skilled in the art 25 that colorants, flavouring agents and non-therapeutic amounts of other compounds may be included in the formulation.

In one embodiment the antioxidant is selected from the group consisting of tocopherol, detersome mesylate, 30 methyl paraben and ascorbic acid.

In yet another embodiment the antioxidant is present in an amount of 1 to 3 g for every litre of water in the formulation. A preferred antioxidant is tocopherol.

35 In a preferred embodiment at least one protease inhibitor is added to the formulation to inhibit degradation of the pharmaceutical agent by the action of

- 6 -

proteolytic enzymes. Of the known protease inhibitors, most are effective at concentrations of from 1 to 3 wt./wt.% of the formulation.

5 Non-limiting examples of effective protease inhibitors are bacitracin, soyabean trypsin and aprotinin. Bacitracin is the most effective of the three named herein when used in concentrations of from 1.5 to 2.0 wt./wt.%. The other two may be used in concentrations of about 1 to 2 wt./wt.%.

10 The pharmaceutical agents may be selected from insulin, antigens selected from the group consisting of MMR (mumps, measles and rubella) vaccine, typhoid vaccine, hepatitis A vaccine, hepatitis B vaccine, herpes simplex virus, bacterial toxoids, cholera toxin B-subunit, influenza vaccine virus, whooping cough vaccine virus, vaccinia virus, adenovirus, canary pox, polio vaccine virus, malaria vaccine virus, bacillus calmette geurin (BCG), klebsiella pneumoniae, HIV envelop glycoproteins and cytokins and other agents selected from the group consisting of bovine somatropine (sometimes referred to as BST), estrogens, androgens, insulin growth factors (sometimes referred to as IGF), interleukin-I, interleukin-II and cytokins. Three such cytokins are interferon- $\beta$ , interferon- $\gamma$  and tuftsin.

15

20 Examples of bacterial toxoids are tetanus, diphtheria, pseudomonas A, mycobacterium tuberculosis. Examples of HIV envelop glycoproteins are gp 120 and gp 160 for AIDS vaccines. Examples of anti-ulcer H<sub>2</sub> receptor antagonists are ranitidine, cimetidine and famotidine, and other anti-ulcer drugs are omeprazole, cesupride and misoprostol. An example of a hypoglycaemic agent is glipizide. Insulin is used for the control of diabetes.

25

30 As will be understood by those skilled in the art, two or more pharmaceutical agents may be combined for specific effects. The necessary amounts of active ingredient can be determined by simple experimentation.

- 7 -

Specific pharmaceutical agents which are particularly suited to this invention are insulin, heparin, low molecular weight heparin, hirugen, hirulos and huridine.

5 In a further embodiment the pharmaceutical agent is insulin.

The method of making the formulation is easy. Typically the absorption enhancing compounds are added to cold water and vigorously mixed. The pharmaceutical agent or agents, any antioxidants, inorganic salts, 10 protective polymers, protease inhibitors and other ingredients, e.g. colouring matter, flavourings, are then added and mixed until the solution is homogeneous.

In the selection of a suitable absorption enhancing compound combination, it has been found that the amount 15 of total absorption enhancing compound should be less than about 10 wt./wt.% of the formulation and preferably from 1 to 5 wt./wt.%. Frequent use or prolonged use of higher concentrations of absorption enhancing compounds are likely to be harmful to linings and tissues in the 20 gastrointestinal tract, and may cause diarrhoea. It is believed that the optimum range for most combinations is from 1.5 to 3.5 wt./wt.%

In general, advantages of the present formulation 25 are that adverse reactions are decreased and bioavailability is increased. Furthermore, manufacture of the formulation is simple. Due to the liquid nature of the formulation, ingestion is easy, the action of the pharmaceutical agent can occur very rapidly, e.g. within 10-15 minutes, and the problem of gastric emptying is 30 minimized.

The invention is now exemplified by reference to 35 insulin, although this is not to be taken as limiting. In the case of insulin, oral administration provides for rapid onset of action, gives a long duration of action, is convenient and is free from the discomfiture of injection. In addition, it more closely mimics normal physiological insulin secretion. The present oral

- 8 -

insulin may serve as the sole substitution of insulin injection in the case of insulin dependent diabetes mellitus and pharmacologic therapy for non-insulin dependent diabetes mellitus.

5 The invention is illustrated by the following non-limiting examples.

Example I

10 0.2 g of chenodeoxycholate, 0.2 g of deoxycholate, 0.2 g polyoxyethylene 9-lauryl ether were dissolved in a small quantity of cold (4°C) distilled water which contained 0.2% gelatin and 0.9% sodium chloride.

15 Dissolution was effected with rapid stirring, and the volume topped up to 9 ml with distilled water. To this clear suspension was added 1 ml of Novolin-R (trade mark) fast acting insulin. The mixture was stirred continuously to give a homogenous solution. One millilitre aliquots of this solution (10 IU insulin) were then administered orally to diabetic rats according to the following protocol. Several batches were made in

20 order to feed to the number of rats in the study.

25 Fifty-five genetically diabetic (urine glucose positive) male wistar BB strain rats weighing 300-400 g were used in the study. The rats were grouped in five groups of eleven rats each. The rats were monitored for diabetes by blood glucose testing using an Accuchek-III (trade mark) glucometer. Diabetes was confirmed by severe hyperglycaemia, with blood glucose levels of greater than 30 mmol/L.

30 At the beginning of the experiment, each rat was numbered and bled for a blood glucose level measurement. Each rat was gavaged with a 1 ml solution containing 3 parts Hanks balanced salt solution to 7 parts sodium bicarbonate to neutralize the stomach acid. One millilitre portions of the oral insulin formulation prepared as above was mixed with 1 ml of saline solution portions and then administered to the rats with a stainless steel gavage tube. One dose was administered

- 9 -

per rat per day. Blood was removed via an implanted angiocatheter in a tail vein for determination of serum insulin levels at 0, 2, 5, 10, 15 30, 45, 60, 90 and 120 minutes after administration of the dose. The resultant sera were frozen and sent to a laboratory for analyzing total serum insulin levels by radioimmunoassay. In addition, 10  $\mu$ l blood samples were drawn from each rat at 0, 30, 60, 120, 180, 240, 300, 360 minutes and 24 hours after administration of the dose, for glucose level analysis. The results for 22 of the rats are shown in Table I, and for 5 of the rats are shown in Table II.

Table I, Changes in blood glucose levels (mmol/L):

Rat	Time (hours)							
	0	0.5	1.0	2.0	3.0	5.0	6.0	24.0
15	1	30.0	21.2	13.1	10.3	12.4	16.5	18.2
	2	29.5	26.0	12.8	11.0	13.1	17.4	16.9
	3	28.7	25.5	21.5	7.7	12.8	16.1	21.8
	4	28.0	19.1	13.4	10.1	15.3	19.8	20.8
20	5	30.8	18.0	12.1	10.0	12.3	13.0	21.7
	6	28.6	13.2	10.1	9.2	13.4	15.3	18.8
	7	28.9	23.4	18.0	6.2	11.8	16.6	22.6
	8	30.1	18.3	10.4	7.2	9.6	17.1	23.2
25	9	26.8	12.1	10.7	6.9	13.8	16.8	18.7
	10	27.3	18.1	11.5	6.4	11.4	18.1	23.2
	11	28.7	16.6	11.2	5.1	10.0	19.1	22.0
	12	28.0	18.0	12.8	11.6	14.3	16.8	20.2
	13	28.8	25.2	12.5	10.3	16.4	19.1	20.4
30	14	28.0	19.1	13.4	11.1	15.5	19.7	25.6
	15	25.8	13.2	10.1	8.7	13.0	16.1	21.7
	16	27.7	23.4	14.1	10.8	12.4	17.0	23.7
	17	28.3	18.3	11.1	8.2	13.4	16.2	24.8
	18	28.8	20.9	11.4	7.8	13.0	16.6	19.2
	19	28.0	22.3	14.3	6.9	14.5	19.3	21.3
								24.8

- 10 -

**Table I continued**

Rat	Time (hours)							
	0.0	0.5	1.0	2.0	3.0	5.0	6.0	24.0
20	27.1	16.0	11.2	7.7	13.6	17.9	20.4	28.0
21	26.8	17.5	10.1	5.7	14.3	19.2	27.7	28.0
22	27.3	14.2	12.5	6.9	11.4	23.3	27.8	27.9

**Table II, Plasma insulin levels ( $\mu$ U/ml):**

Rat		23	24	25	26	27
10	Time mins	5	15.2	12.1	16.7	14.2
		7	48.3	37.5	43.3	40.6
		10	54.7	52.8	55.6	49.5
		15	52.6	45.2	50.5	48.7
		30	32.0	35.3	31.0	28.7
		45	19.2	12.2	12.5	11.8
		60	7.7	5.8	4.0	5.1
		90	3.5	4.4	2.1	3.2
		120	2.0	2.8	1.6	1.9

Table I shows that the orally administered insulin formulation has a metabolic effect on the blood glucose levels. It is clear that within 2 hours the blood glucose level reached a normal level (7 mmol/L) from an initial level of about 30 mmol/L. The onset of action was very fast, i.e. about 10 minutes after administration and maximum serum level was achieved within 15 minutes and the effect lasted for 24 hours with a single dose of the oral insulin formulation.

#### Example II

For comparative purposes, a composition containing only one absorption enhancer was tested. A composition comprising 0.3 g sodium cholate, 0.2 soyabean trypsin inhibitor, 16 IU insulin, 8.4 ml saline solution and 0.2 g polyethylene glycol in 10 ml of distilled water was prepared. The composition is not within the scope

- 11 -

of the present invention. The procedure of Example I was followed and 1 ml aliquots were gavaged to rats. 10  $\mu$ l blood samples were drawn from each rat at 0 mins, 30 mins, 1, 2, 3, 4 and 24 hours after administration of 5 the dose, for glucose level analysis. The results are shown in Table III.

Table III, Changes in blood glucose levels (mmol/L):

Rat	Time (hours)							
	0.0	0.5	1.0	2.0	3.0	4.0	24.0	
10	31	30.3	28.5	26.0	28.0	20.1	15.8	28.0
	32	28.5	28.0	27.1	25.0	28.0	21.7	28.0
	33	29.0	28.0	26.0	28.1	28.0	24.2	28.2
	34	28.7	28.1	26.5	23.0	26.9	23.0	29.6
	35	27.8	28.2	28.0	24.1	21.3	18.2	30.3
	36	28.9	27.5	28.0	20.5	21.5	23.8	28.0
	37	28.1	28.2	26.5	24.0	27.5	28.0	29.2
	38	28.9	26.8	24.0	19.0	20.2	21.8	29.7

20 Table III shows that the orally administered insulin formulation which contains only one absorption enhancer, i.e sodium cholate, has very little metabolic effect on the blood glucose levels.

Example III

25 0.25 g of oleic acid, 0.25 g of linoleic acid, 0.1 g sodium lauryl sulphate and 0.25 ml of Tween® 80 polyoxyethylene sorbitan ester were dissolved in a small quantity of cold ( $4^{\circ}\text{C}$ ) distilled water which contained 0.2% gelatin and 0.9% sodium chloride. Dissolution was effected with rapid stirring, and the volume topped up to 9 ml with distilled water. To this clear suspension 30 was added 1 ml of Novolin-R (trade mark) fast acting insulin. The mixture was stirred continuously to give a homogenous solution.

35 Aliquots of the solution were administered to

- 12 -

5

diabetic (urine glucose positive) male wistar BB strain rats as in Example I and blood glucose levels were determined at intervals of 0 min, 30 min, 1, 2, 3 and 5 hours after administration of the dose. The results are shown in Table IV.

Table IV, Changes in blood glucose levels (mmol/L):

Rat	Time (hours)					
	0.0	0.5	1.0	2.0	3.0	5.0
41	28.5	21.8	11.8	8.9	13.2	12.6
42	29.0	18.3	18.0	13.2	12.8	14.8
43	28.7	12.0	8.7	9.8	11.4	13.4
44	30.1	18.1	10.4	8.8	13.8	25.6

15

Example IV

20

The experiment of Example III was repeated, except that the composition comprised 0.25 g of disodium EDTA, 0.25 g of sodium salicylate and 0.25 g of polyoxyethylene 9-lauryl ether dissolved in a small quantity of cold (4°C) distilled water which contained 0.2% gelatin and 0.9% sodium chloride. The results are shown in Table V below.

Table V, Changes in blood glucose levels (mmol/L):

25

Rat	Time (hours)					
	0.0	0.5	1.0	2.0	3.0	5.0
51	28.6	28.1	17.9	15.2	13.8	25.0
52	29.8	16.1	13.0	11.8	12.2	18.2
53	29.6	17.0	10.3	10.1	15.1	23.7
54	30.1	11.4	11.5	9.9	11.8	15.3

30

Example V

35

The experiment of Example III was repeated, except that the composition comprised 0.1 g of monoolein, 0.25 g of deoxycholate and 0.25 g of polyoxyethylene 9-

- 13 -

lauryl ether dissolved in a small quantity of cold (4°C) distilled water which contained 0.2% gelatin and 0.9% sodium chloride. The results are shown in Table VI.

5

Table VI, Changes in blood glucose levels (mmol/L):

10

Rat	Time (hours)					
	0.0	0.5	1.0	2.0	3.0	5.0
61	28.1	14.5	11.2	10.2	10.3	14.3
62	28.0	26.0	21.9	12.2	8.0	15.8
63	29.8	24.3	20.0	15.4	12.8	14.2
64	29.5	18.4	14.2	10.2	11.0	17.0

15

Examples III, IV and V all show the metabolic effect on the blood glucose levels of the orally administered insulin.

CLAIMS:

1. A liquid pharmaceutical agent formulation suitable for oral or nasal delivery comprising a proteinic pharmaceutical agent, water and at least two absorption enhancing compounds selected from the group consisting of sodium salicylate, sodium lauryl sulphate, disodium ethylenediaminetetraacetic acid (disodium EDTA), oleic acid, linoleic acid, monoolein, lecithin, lysolecithin, deoxycholate, sodium deoxycholate, chenodeoxycholate, taurodeoxycholate, glycochenodeoxycholate, polyoxyethylene X-lauryl ether wherein X is from 9 to 20, sodium tauro-24, 25-dihydrofusidate, polyoxyethylene ether, polyoxyethylene sorbitan esters, p-t-octylphenoxy polyoxyethylene, N-lauryl- $\beta$ -D-maltpyranoside, 1-dodecylazacycloheptane-2-azone and phospholipids, wherein the amount of each of the absorption enhancing compounds is present in a concentration of from 1 to 10 wt./wt.% of the total formulation.
2. A liquid pharmaceutical agent formulation according to Claim 1 wherein the concentration of each of the absorption enhancing compounds is from 1 to 5 wt./wt.% and especially from 1.5 wt./wt.% to 3.5 wt./wt.%
3. A liquid pharmaceutical agent formulation according to Claim 2 wherein the absorption enhancing compounds are selected from the group consisting of a combination of deoxycholate, chenodeoxycholate, and polyoxyethylene 9-lauryl ether, a combination of sodium salicylate, deoxycholate, chenodeoxycholate, and polyoxyethylene 9-lauryl ether, a combination of sodium deoxycholate, chenodeoxycholate, polyoxyethylene 9-lauryl ether and monoolein, a combination of deoxycholate, chenodeoxycholate and sodium salicylate, a combination of deoxycholate, sodium salicylate and sodium lauryl sulphate, a combination of deoxycholate, chenodeoxycholate, polyoxyethylene 9-lauryl ether and

- 15 -

- sodium tauro-24, 25-dihydrofusidate, a combination of sodium deoxycholate, chenodeoxycholate, polyoxyethylene 9-lauryl ether and sodium tauro-24, 25-dihydrofusidate, a combination of deoxycholate, chenodeoxycholate;
- 5       taurodeoxycholate, polyoxyethylene 9-lauryl ether and monoolein, a combination of chenodeoxycholate, glycochenodeoxycholate, polyoxyethylene 9-lauryl ether and sodium tauro-24, 25-dihydrofusidate, a combination of chenodeoxycholate, sodium lauryl sulphate and
- 10      disodium EDTA, a combination of deoxycholate, chenodeoxycholate, polyoxyethylene 9-lauryl ether and disodium EDTA, a combination of sodium salicylate, disodium EDTA and polyoxyethylene 9-lauryl ether, a combination of monoolein, oleic acid and polyoxyethylene
- 15      sorbitan ester, a combination of monoolein, oleic acid, polyoxyethylene sorbitan ester and sodium lauryl sulphate, and a combination of linoleic acid, monoolein and sodium salicylate.
4.      A liquid pharmaceutical agent formulation according  
20     to Claim 3 wherein the absorption enhancing compound compositions are selected from the group consisting of i) a combination of deoxycholate, chenodeoxycholate and sodium salicylate, ii) a combination of sodium salicylate, deoxycholate and sodium lauryl sulphate,
- 25     iii) a combination of chenodeoxycholate, sodium lauryl sulphate and disodium EDTA and iv) a combination of monoolein, oleic acid and polyoxyethylene sorbitan ester, and v) a combination of deoxycholate, chenodeoxycholate and polyoxyethylene 9-lauryl ether.
- 30     5.      A liquid pharmaceutical agent formulation according to any one of Claims 1, 2 or 3 wherein the formulation contains at least one protective polymer for slow release of the pharmaceutical agent.
- 35     6.      A liquid pharmaceutical agent formulation according to any one of Claims 1, 2 or 3 wherein the formulation contains at least one protective polymer selected from the group consisting of polyvinyl alcohol, polyethylene

- 16 -

glycol and gelatin.

7. A liquid pharmaceutical agent formulation according to any one of Claims 1, 2 or 3 wherein the formulation contains an antioxidant.

5 8. A liquid pharmaceutical agent formulation according to any one of Claims 1, 2 or 3 wherein the formulation contains an antioxidant selected from the group consisting of tocopherol, dexteroxime mesylate, methyl paraben and ascorbic acid.

10 9. A liquid pharmaceutical agent formulation according to any one of Claims 1, 2 or 3 wherein the formulation contains at least one protease inhibitor.

10. A liquid pharmaceutical agent formulation according to any one of Claims 1, 2 or 3 wherein the formulation 15 contains a protease inhibitor selected from the group consisting of bacitracin, soyabean trypsin and aprotinin in a concentration of from 1 to 3 wt./wt.%.

11. A liquid pharmaceutical agent formulation according to any one of Claims 1, 2 or 3 wherein the 20 pharmaceutical agent is selected from the group consisting of insulin, heparin, hirugen, hirulos, huridine, mumps, measles and rubella vaccine, typhoid vaccine, hepatitis A vaccine, hepatitis B vaccine, herpes simplex virus, bacterial toxoids, cholera toxin B-subunit, influenza vaccine virus, whooping cough vaccine virus, vaccinia virus, adenovirus, canary pox, polio vaccine virus, malaria vaccine virus, bacillus calmette geurin (BCG), klebsiella pneumoniae, HIV envelop glycoproteins, bovine somatropine, estrogens, androgens, insulin growth factors, interleukin-I, interleukin-II and cytokins.

25 12. A liquid insulin formulation according to Claim 3 wherein the pharmaceutical agent is insulin.

13. A liquid insulin formulation according to Claim 12 30 wherein the formulation also contains at least one inorganic salt which opens channels in the gastrointestinal tract, at least one protective polymer

- 17 -

and at least one protease inhibitor.

14. A liquid insulin formulation according to Claim 13 wherein the inorganic salt is selected from the group consisting of sodium chloride, potassium chloride, calcium chloride, zinc chloride and sodium bicarbonate, the protective polymer is selected from the group consisting of polyvinyl alcohol, polyethylene glycol and gelatin, and the protease inhibitor is selected from the group consisting of bacitracin, soyabean trypsin and aprotinin.

10 15. A liquid insulin formulation according to Claim 14 which also contains an antioxidant.

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/CA 96/00305

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 A61K38/28

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LANCET, vol. 2, December 1989, pages 1518-1519, XP000605224 CHO, Y. W. _FLYNN, M.: "ORAL DELIVERY OF INSULIN" see page 247, column 2, paragraph 2 see page 248, column 2, paragraph 2 --- ---	1,11,12
X	PHARMAZIE, APR 1983, 38 (4) P246-8, GERMANY, EAST, XP000605222 AXT J ET AL: "[Biopharmaceutical studies on phospholipid liposomes as carriers for the oral administration of insulin]" see page 1518, column 1, paragraph 2 - page 1518, column 2, paragraph 2 --- -/-	1,11,12

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

## \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 October 1996	04.11.96
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Authorized officer  Leherte, C

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/CA 96/00305

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 272 097 (NOVO INDUSTRI AS) 22 June 1988 see abstract see page 4, paragraph 1 - paragraph 4 ---	1,11,12
A	AT,B,392 906 (HOFFMANN LA ROCHE) 10 July 1991 see claims see page 9, line 34 - line 36 ---	1-15
A	PHARM RES (N Y), 6 (10). 1989. 853-856., XP000604357 DEURLOO M J M ET AL: "ABSORPTION ENHANCEMENT OF INTRANASALLY ADMINISTERED INSULIN BY SODIUM TAURODIHYDROFUSIDATE STDHF IN RABBITS AND RATS" see abstract ---	1-15
A	PHARM RES (N Y), 7 (4). 1990. 370-375., XP000604501 TENGAMNUAY P ET AL: "BILE SALT FATTY ACID MIXED MICELLES AS NASAL ABSORPTION PROMOTERS OF PEPTIDES II. IN-VIVO NASAL ABSORPTION OF INSULIN IN RATS AND EFFECTS OF MIXED MICELLES ON THE MORPHOLOGICAL INTEGRITY OF THE NASAL MUCOSA" see abstract ---	1-15
A	INT. J. PHARM., 1991, 76/1-2 (61-70), NETHERLANDS, XP000604356 CHANDLER S.G. ET AL: "Nasal absorption in rats. II. Effect of enhancers on insulin absorption and nasal histology" see page 62, column 1, paragraph 4 - paragraph 5 see page 62, column 2, paragraph 3 ---	1-15
A	EP,A,0 200 383 (LILLY CO ELI) 5 November 1986 see claims ---	1-15
A	US,A,4 789 660 (ENEVER ROBIN P ET AL) 6 December 1988 see claim 2 ---	1-15
A	EP,A,0 463 653 (ERBA CARLO SPA) 2 January 1992 see column 4, paragraph 6 - column 5, paragraph 3 -----	1-15

**INTERNATIONAL SEARCH REPORT**

International application No.

**PCT/CA 96/00305****Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
2.  Claims Nos.: 1-15 because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
**In view of the large number of compounds which are defined by the wording of the claims, the search has been performed on the general idea and compounds mentioned in the examples of the description.**
3.  Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest.  
 No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/CA 96/00305

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0272097	22-06-88	AU-B-	606121	31-01-91
		AU-A-	1085888	15-07-88
		CA-A-	1326210	18-01-94
		DE-A-	3780925	10-09-92
		WO-A-	8804556	30-06-88
		ES-T-	2044957	16-01-94
		FI-B-	94024	31-03-95
		HR-A-	930276	30-04-96
		HU-B-	209247	28-04-94
		IE-B-	61110	05-10-94
		IL-A-	84835	25-01-94
		JP-B-	7068149	26-07-95
		JP-T-	1501550	01-06-89
		NO-B-	175566	25-07-94
		SU-A-	1837869	30-08-93
		US-A-	5179079	12-01-93
		ZA-A-	8709284	16-06-88
AT-B-392906	10-07-91	NONE		
EP-A-0200383	05-11-86	AU-B-	584184	18-05-89
		AU-A-	5606386	23-10-86
		CA-A-	1274774	02-10-90
		JP-A-	62207221	11-09-87
US-A-4789660	06-12-88	NONE		
EP-A-0463653	02-01-92	DE-D-	69106947	09-03-95
		DE-T-	69106947	06-07-95
		JP-A-	4235927	25-08-92

**THIS PAGE BLANK (USPTO)**